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Stages of the Econometric Research and Modeling Process

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Abstract: This article describes the stages of econometric research and modeling process and model, modeling, economic model, economic-mathematical model, material model, abstract model, theoretical-analytical model, standard model, functional model, deterministic model, static model, structural model, econometrics, opinions and comments on correlation, regression, metrics, trend, autocorrelation are given and described.

Key words: model, modeling, economic model, economic-mathematical model, material model, abstract model, theoretical-analytical model, standard model, functional model, deterministic model, static model.

Econometrics addresses all of the above issues and describes how to solve these problems. One should not assume that once a student has knowledge of a textbook, he or she will immediately become an experienced econometricist. There are two reasons for this. First, there are many technical (theoretical) materials not included in this textbook. Second, even if the theoretical knowledge of two economists is always the same, their assumptions and forecasts will be different. This is because econometrics means more than applying theoretical knowledge. This requires a critical look at the importance of "theorems" in concrete economic knowledge and practical applications. The following steps can be identified in any econometric study:

- Statement of the problem (qualitative analysis of the relationship of economic variables
- depending on (Y_i) and independent variables (X_{ik}) selection);
- data collection, analysis of their quality;
- model specification (Y_i and X_{ik} form of relationship between);
- evaluation of model parameters;
- interpretation of results.

After that, the formation of the research topic and goals is expedient, the structural or functional elements corresponding to this purpose are separated in the economic system under consideration, and the most important qualitative characteristics of these elements are determined. The relationship between model elements is described verbally, qualitatively. To specify the model, symbolic symbols are introduced for the considered properties of the economic object and, if possible, the relationship between them is formalized. Thus, a mathematical model is formed.

When evaluating the parameters of the model, the values of the unknowns are determined by one of the optimal methods in each individual case. The quality of the calculations found is then checked, i.e. how accurately the parameters are determined, their significance and other statistical characteristics, as well as the probability that the model is consistent with empirical data and theoretical assumptions. This analysis is mainly performed according to the scheme of testing statistical hypotheses. At this stage, not only the form of the model is improved, but also the composition of the variables that explain it (in particular, the demand for a product is determined not only by its price, but also by other factors).

The interpretation of the obtained results is that the calculations are performed on the basis of a mathematical model and an analysis of the obtained solution. If the model meets the quality requirements, it can be used to forecast or analyze the internal mechanism of the processes being studied. The calculated econometric model can be used for structural analysis, including feedback on economic theory, as well as for forecasting and the development of appropriate economic policy. The object of study of econometrics are economic and mathematical models constructed taking into account random factors. Such models are called econometric models.

For more information about the object under study, it is possible to construct several models that describe it from different angles. Modeling is the process of creating, studying, and applying models. The main feature of modeling is that the model works as a tool that puts the researcher between himself and the object to study the latter. Thus, the modeling process involves three elements: a model that mediates the relationship of the research object (researcher), the research object (original), and the object being studied with the subject being studied.

Any econometric research is conducted on the basis of data obtained as a result of statistical observation of economic processes and events. Each economic event and process is represented by macro or micro statistical indicators. Statistical indicators known from the science of statistical theory are absolute, relative, and averages, which have their own quantitative and qualitative aspects. Hence, economic processes are represented by the above indicators. The data obtained and analyzed as a result of statistical observation form the statistical base of econometric models.

Since economic processes in the context of market relations are inextricably linked to each other at both the micro and macro levels, their relationships are analyzed using the links of indicators that reflect economic processes. The analysis of the connections is carried out using one or another econometric model that reflects the processes. To do this, all the steps of the above-mentioned modeling are carried out and an econometric model is created. The econometric model identifies the factors influencing the economic process, their importance, the development trends of the process.

The essence of the modeling process is explained by the scheme shown in Figure 1 below. Let's take a look at some A's. Initially, the researcher, using some tools, constructs a model B - a conditional image of object A, roughly creating a model of object A in its original form. This issue requires detailed analysis and solution depending on the specific situation. Obviously, the model loses its meaning both if it is similar to the original and if it differs too much from the original. After construction, Model B will be inspected. The end result of such a study is to obtain a set of knowledge about Model B. Then, the knowledge gained about the model is interpreted, i.e., they are transferred from the model to the original and a set of knowledge about object A is formed on the basis of the knowledge obtained from model B. Finally, a practical examination of the knowledge gained from modeling concludes with their use in the management of Object A.

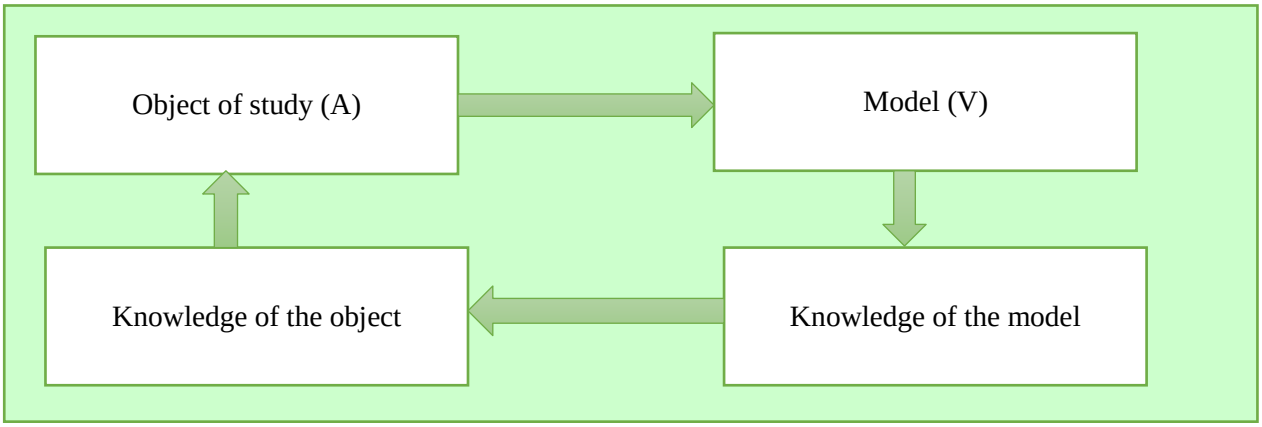

Figure 1. The essence of the modeling process

Note that the modeling method is widely used not only in economic practice but also in theory. Over time, a great deal of experience has been gained in building models, which have been used in the analysis of economic processes and events. In particular, almost all the work of Nobel laureates in economics is related to the use of modeling.

A mathematical model represents the properties of an object in mathematical language, i.e., the use of mathematical symbols and relationships: functional and logical dependencies, inequalities, algebraic, differential or other systems of equations, and so on. Mathematical modeling is a method of research based on events and processes that have different natures but represent the same mathematical connections. Today, mathematical modeling is a leader in economic research, applied planning, and management, and is closely linked to computerization. In most cases, economic laws are expressed in a relatively simple mathematical form. For example, consider the consumption function:

$lnC = \beta_0 + \beta_1 lnY + \beta_2 lnP$ (1.1)

here,

C - per capita consumption of certain food products in a given year;

Y - real per capita income in that year;

P - adjusted (deflated) price index for the total cost index of this product;

β_0, β_1, β_2 - are constants. This equation is called the behavioral equation. It describes the average behavior of a consumer in relation to the purchase of a particular food product based on the relative level of product prices and real income per capita. The law of conduct β_0, β_1, β_2 - is determined by finding the values of the coefficients. Accordingly, the task of econometrics is to determine these coefficients from a set of corresponding observations. But this is not the only task.

Many other questions related to econometrics can be asked, for example: Are there variables that need to be added to the equation (e.g., non-food prices)? Should some variables be excluded from the equation? How accurately are our data measured, do they reflect what they are supposed to represent? Is it true that the model is linear? Is economic theory correct? Is the model complete? Is it enough to study a macroeconomic equation like the one above? to answer our questions or to study individual (micro) data as well? The above model is static. Perhaps the dynamic model is more appropriate. For example, it can be assumed that last year's income may affect current consumption levels. In this case, we need to include it in the equation as well.

Any economic indicators included in the equation allow to determine the laws of change of the process, trends in the development of the economic situation and future forecasting using econometric models as a

result of identifying trends. In solving a given problem, economic data is constructed in the form of a dynamic series or dynamic column, i.e., they change over time. In this case, the number of observations is required to be 4-5 times greater than the number of factors. The importance of models based on econometric modeling is reflected in the following:

1) Material, labor and monetary resources are used rationally using econometric methods.
2) Econometric methods and models serve as a leading tool in the development of economics and natural sciences.
3) It will be possible to make some adjustments during the general implementation of forecasts made using econometric methods and models.
4) With the help of econometric models, it is possible not only to analyze economic processes in depth, but also to reveal their new unstudied laws. They can also be used to predict the future development of the economy.
5) Econometric methods and models, along with the automation of computational work, facilitate mental work, organize and manage the work of economic workers on a scientific basis.

The main econometric methods are mathematical statistics and econometric methods, and the methods of mathematical statistics - analysis of variance, correlation analysis, regression analysis, factor analysis, index theory. Econometric methods include the theory of economic growth, the theory of the function of production, the theory of supply and demand.

The process of studying econometrics is the process of creating econometric models of economic processes, the main method used is the method of correlation-regression analysis. Econometric modeling is a complex of scientific directions of economic theory, probability theory, mathematical statistics and computer technology.

In economics, laws are manifested as the interrelationship of economic performance. Gross product Y Resources in the enterprise ($x_1,x_2,\ldots,x_n$) depends on consumption and it $Y=F(x_1,x_2,\ldots,x_n)$ is written as

This is called the relative model and it represents the dependence of the variables. In general, the Y variable (resultant indicator) is a free variable ($x_1,x_2,\ldots,x_n$) dependence can be written as follows $Y=F(x_1,x_2,\ldots,x_n)$. Free variables are also called factors, regressors, in econometrics.

If given $\bar{X} = (x_1, x_2, \ldots, x_n)$ such a relationship is called functional if the values of Y directly correspond to the set. The feature of the functional dependence is that in each case the value of the complete factor corresponds to the exact resultant value, and this mechanism is written in the form of an equation.

But in an economy, in many cases, the amount of outcome indicators depends on many objective and subjective (people's goal-oriented activities) factors, sometimes random factors. In addition, in the absence of complete information in the study of economic dependencies, there may not be a complete list of factors influencing the indicator under study, or the impact of factors may be different. If the influencing factors are random, their impact can be determined on the basis of probability. Such dependencies are called stochastic and are expressed as follows:

$Y=F(x_1, x_2, \ldots, x_n) + \varepsilon$

here: x_i free variables (actions);

$F(x_1,x_2,\ldots,x_n)$ the resultant indicator Y is the unspecified portion of the weight of the factors considered

ε a quantity that represents a change in the outcome indicator under the influence of uncontrollable factors. Thus, when constructing econometric models, it is ensured that the amount studied is random. The relationship between the variables under study is usually determined using qualitative analysis rather

than using mathematics, and its essence and the reason for the internal relationship are determined.

The purpose of econometric modeling $F(x_1,x_2,\ldots,x_n)$ it is necessary to determine the appearance of the function and find an equation that corresponds to the nature of the phenomenon under study. To find an adequate equation for this, the numerical expression of the dependence and its stability are determined using variance, correlation and regression analyzes. Here are some of them (Figure 1).

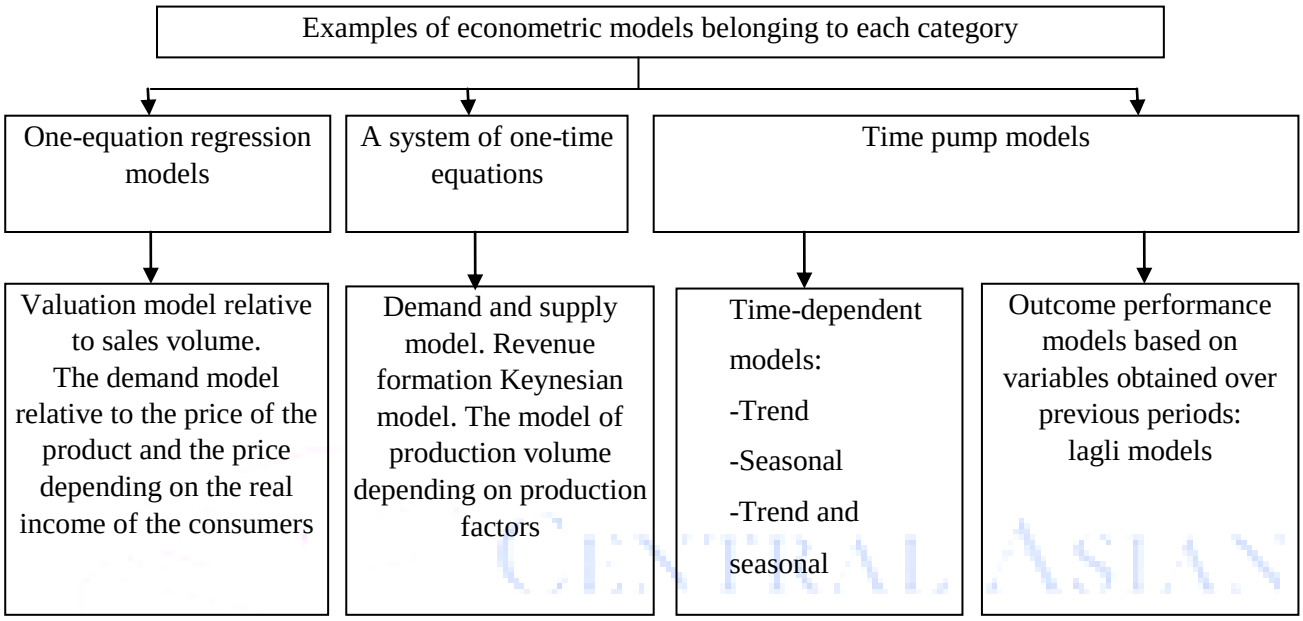

Figure 2. Types of econometric models

One-equation regression models: $Y = F(\bar{X}, a) + \varepsilon$, here $\bar{X} = (x_1, x_2, \ldots, x_n)$ – economic indicators involved as variables; a – vector of model parameters.

System of one-time equations: These models are in the form of system equations. A system can consist of regression equations, and each can be composed of dependent variables in other equations other than free variables. In practice, such systems are made recursive. To do this, we first find the related indicators (variables) and they depend only on the free variables. Then the free variables and the found related variables are determined. Thus each Y consists only of free variables and variables defined in the system. Systematic econometric equations require a complex mathematical apparatus as opposed to simple regression equations.

Time Range Models: The sequential placement of a particular indicator over time is called a time series. The values of the variable under study are called series levels.

Time series models have only one free variable t - time, and they are single-factor models. In the time series consisting of economic indicators, the following components can be identified: trend, seasonal, cyclical and random components. Trend is a long-term stable and recurring component of the process. For example: a continuous increase in sales of a product over a period of time, a change in the production of a product, and so on.

There may be a constant oscillating component around the time series trend of economic processes. If it oscillates periodically throughout the year, it is called seasonal oscillations. If the oscillation lasts for several years, we call it a cyclic oscillation. When seasonal and cyclic components are constant, they are called the structural component of time series. The time series does not always have to have these components.

Econometric models consisting of cyclic oscillations can be written in an additive or multiplicative form.

Time models can also include a large number of complex additive prediction and autoregression models.

Types of data of econometric models: Spatial - data on various objects in a given period, for example: Production volume of enterprises of the region, the number of employees.

In terms of time - several period data on the exact object, for example: consumer goods index, employment in subsequent years, etc. The variables of the econometric models can be conditionally divided into the types in Figure 3 below.

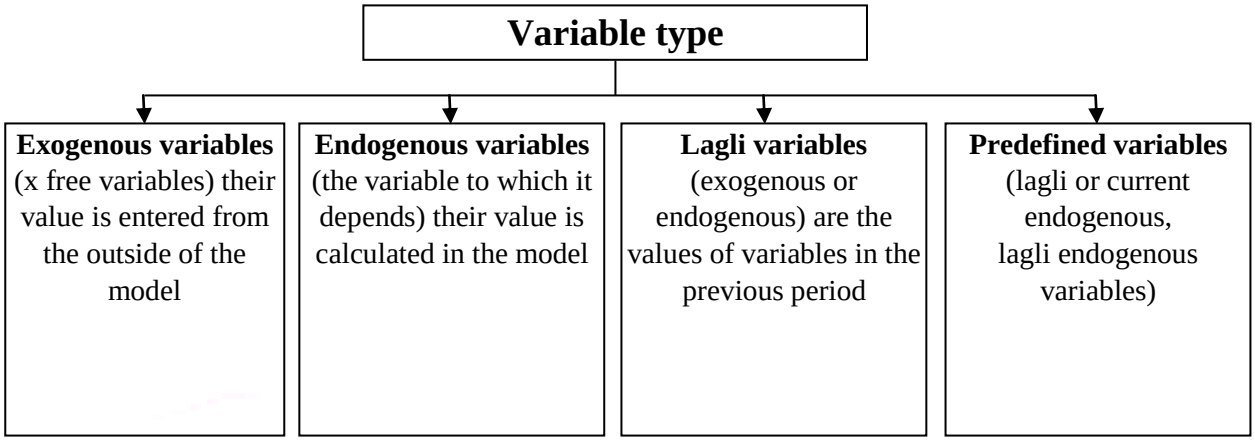

Figure 3. Variable type

Mathematical models are widely used in the study of business, economics, social sciences, economic activity, and even political processes. Mathematical models are useful for a more complete understanding of the nature of ongoing processes, for their analysis. A model built and validated based on the observed values of the explanatory variables (already existing) can be used to predict the future values of the dependent variable or a set of values of other explanatory variables. There are three main classes of models used for analysis and / or forecasting. Time series models include trend models of this class:

$y(t)=T(t)+et$

here: T(t) - time trend of a given parametric type (for example, linear $T(t) =a+bt$),

et - random (stochastic) component;

seasonality:

$y(t)=S(t)+et$,

where: S (t) is the periodic (seasonal) component;

trend and seasonality:

$y(t)=T(t)+S(t)+et$ (additive) or $y(t)=T(t)S(t)+et$ (multiplicative),

Time series models include many complex models, such as adaptive forecasting models, autoregressive and moving average (ARIMA) models, and more. Their common feature is that they explain the motion of a time series only on the basis of its previous values. Such models can be used to study and forecast, for example, air ticket sales, demand for ice cream, short-term interest rate forecasts, and more.

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